

UNITED STATES  
DEPARTMENT OF AGRICULTURE  
CIRCULAR No. 433

Washington, D. C.

June 1937

CROW-WATERFOWL  
RELATIONSHIPS

BASED ON PRELIMINARY STUDIES ON  
CANADIAN BREEDING  
GROUNDS

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## INTRODUCTION

With the object of obtaining a current insight into the relationship of crows to waterfowl on their breeding grounds, a study was inaugurated in the spring of 1934 and continued through the nesting season of that and the following year. As originally planned, it called for field studies both in Canada and in the northern United States, but drought conditions had so drastically reduced the breeding population of ducks within our borders by the spring of 1934 that, after a futile effort to locate suitable areas in this country, plans were changed and the studies were restricted to Canadian areas in Saskatchewan and Alberta, where ducks and crows could be found in reasonable abundance and in close association.<sup>1</sup>

The scenes of the studies cover three rather circumscribed areas—two in Saskatchewan and one in Alberta—and, although the writer believes that the facts revealed and the conclusions reached are reasonably accurate for these areas, no claim is made that the findings

<sup>1</sup> Grateful acknowledgment is made to both Dominion and Provincial officials in Canada, through whose kind cooperation in the granting of permits and the loan of equipment the work was facilitated; to O. C. Furniss, of Prince Albert, Saskatchewan, for volunteered services in the study of nests at Waterhen Lake, Saskatchewan, and in the section about Prince Albert, both in 1934 and 1935; and also to C. S. Williams, of the Biological Survey, who accompanied the writer in 1935, and gave untiring devotion to the field studies, rendered aid in tabulating and computing the results, and, with S. E. Aldous, also of the Biological Survey, assisted in the examination of stomachs of crows collected.

represent a cross-section of crow-waterfowl relationships throughout Canada. As a matter of fact the results obtained in the two areas in Saskatchewan clearly show that there may be great variation in the degree of pressure exerted by the crow at points only 50 miles apart. Much less can the results be construed as representative of what takes place in the Northern States of this country, where as yet there is a lack of adequate information regarding "average" conditions on duck-nesting grounds.

By reason of the character of the nesting environment found and the observed density of the crow population, the areas at Waterhen Lake, Saskatchewan, and the lake region to the southeast of Edmonton, Alberta, presented conditions highly conducive to crow attack upon nesting ducks; in the pot-hole region about Prince Albert, Saskatchewan, the relationship was much less acute.

#### AREAS STUDIED

##### WATERHEN LAKE, SASKATCHEWAN, AND VICINITY

[May 21-July 10, 1934; June 8-July 21, 1935]

Waterhen Lake, about 35 miles on an air line to the southeast of Prince Albert, Saskatchewan, was the scene of most of the nest-history studies in 1934 (pl. 1, A). This lake, lying just south of latitude 53° north and not far from the meridian (105° west) that passes through Denver, Colo., formerly was one of the outstanding nesting and feeding areas of ducks in southern Saskatchewan. More than a decade ago it was drained in an attempt to convert its 10 or more square miles of water surface into agricultural land. This effort failed, however, and in the fall of 1932 the outlet of the drainage system was closed and the waters of the inflowing Carrot River allowed to accumulate. By the summer of 1934 the run-off of two winters had reflooded Waterhen Lake to a depth of about 4 feet at its deeper points, and much of the original marsh environment had been restored. Through the center of this expansive area were the two parallel banks of the canal used to drain the area. These furnished an ample dry nesting habitat for waterfowl. With its water level nearly constant throughout the summer of 1934, Waterhen Lake became the center of attraction for breeding ducks in the section southeast of Prince Albert, and 192 of the 211 nests whose histories were completed during that season were situated on the two canal banks.

In several respects the environment at Waterhen Lake, particularly with respect to the vulnerability of duck nests to attack by crows, deviated from what might be considered normal. Here the ducks could find on the two canal banks high land suitable for nesting sites in the center of a large expanse of marsh. During May and early in June the available cover on these dikes consisted of the dead vegetation of the previous year, largely *Fluminea* and *Carex*, with here and there a few sparse clumps of willow. There was little intrusion by human beings on the dikes other than that of the investigators. The location of nests on the long parallel dikes, however, separated as they were by half a mile to 2 miles from other dry land, had a distinct bearing on their exposure to attack by agencies other than man.

In the first place, it may be explained that crows, which nested abundantly in woodland areas surrounding Waterhen Lake, make a regular practice of flying out to the canal and following the banks, manifestly in search of duck nests. Such performances were observed frequently, and, despite the persecution to which they were subjected by red-winged and yellow-headed blackbirds, the crows persisted in making these forays. The location of this group of nests in a more or less direct line doubtless afforded better chances for discovery by crows than if they had been located irregularly along the meandering border of some marsh or lake shore.

The canal banks also presented a condition somewhat peculiar with respect to small mammalian predators or egg destroyers. Owing to the isolation of the area, such common disturbing elements as domestic livestock, dogs, and feral cats did not enter the picture, but at the ends of the dikes the nests were accessible to skunks. Throughout the entire length of the dikes muskrats were common, although in no instance could depredations on eggs be definitely ascribed to these rodents. The work of weasels and minks came to light at several of the nests. Red-tailed and marsh hawks were present, and evidence of their attack on birds was found, but in no case did it appear to be associated with any of the birds whose nests were under observation.

The outer border of Waterhen Lake presented an environment typical of the edge of any expansive marsh, and the nests located there in 1934 were exposed to attack or disturbance not only by crows but by various small mammals, including roaming dogs, and, on higher land, by ground squirrels. In 1935 all the 42 nests under observation at this lake were on the canal banks and subject to essentially the same hazards that existed there in the previous year.

Twenty-one additional nests under observation in the vicinity in 1934, situated at a number of small lakes, sloughs, and pot holes, were all within easy reach of crows and such other disturbing factors as dogs and livestock.

#### POT-HOLE COUNTRY NEAR PRINCE ALBERT, SASKATCHEWAN

[May 21-July 10, 1934; May 3-July 22, 1935]

Four of the nests recorded in 1934 and 77 of those observed in 1935 were in the pot-hole and small-slough country in the vicinity of Prince Albert, Saskatchewan, and were reported upon by O. C. Furniss of that place. This district, located on the divide between the Transition and Canadian Life Zones, has an undulating surface, with bodies of water that range in size from less than an acre up to 10 or 12 acres. These usually are margined with a healthy stand of *Fluminea*, *Panicularia*, *Carex*, and clumps of *Scirpus* and *Typha*. The surrounding arboreal growth consists mainly of willow and aspen.

Agricultural activities surround and often reach down to the very borders of the pot holes and, as a result, nesting ducks may be exposed to disturbance by grazing livestock, interference by man, and even fire. Although crows appeared to be the outstanding wildlife factor affecting the welfare of duck nests in this vicinity, their relative scarcity there, compared with the other areas studied, made their influence of much less consequence.

## COOKING LAKE DISTRICT, SOUTHEAST OF EDMONTON, ALBERTA

[May 19–July 26, 1935]

An area to the southeast of Edmonton, which for convenience may be referred to as the Cooking Lake district, was chosen for the studies of 1935, not only that information might be available from the Province of Alberta but also that it might serve as a check against results obtained under the somewhat peculiar conditions prevailing on the canal banks at Waterhen Lake, in the adjoining Province. Although some nests studied were on the shores and bays of Cooking Lake itself, by far the greater number were on the islands and shores of other bodies of water in the vicinity, notably Ministik, Hastings, and Big Island Lakes. About three-fourths (167) of the nests of which the histories were completed in 1935 were located on islands in these three lakes; the others were in shore-line marshes, sloughs, or hay fields, or in the "bush." These islands, ranging in size from less than an acre to as much as 15 acres, usually supported in their centers a stand of spruce surrounded by a fringe of poplar, birch, and willow.

Spruces, where present, furnished ideal nesting sites for crows, and at Ministik Lake in particular, one or two nests of crows were to be found on each of the principal islands (pl. 1, *B*). With nesting crows in the center, the ducks making use of the shore line were continually in jeopardy. A crow could not leave its nesting site without passing over an actual or potential duck-nesting area. Even on the islands at Hastings Lake, which supported no stands of spruce, crows were accustomed to make regular trips of half a mile or a mile from the mainland in search of duck eggs.

In other respects, however, the island environment was favorable to nesting ducks, particularly since there was an absence of farm operations, grazing livestock (pl. 2, *A*), wandering dogs, and, to a marked extent, intruding human beings. Evidence of skunks was infrequent on even the larger islands, and on the smaller ones, devoid of arboreal vegetation, it was apparent that mammalian pressure on the duck population was practically nil.

Early in the season the dead growth of the previous year's stand of round bulrush (*Scirpus validus*) and numerous grasses furnished the main nesting cover (pl. 2, *B*). In the district as a whole, there was ample cover of this kind for many times the duck population present. Later in the season the new growth, including dense stands of thistle on some islands, created a cover from which even the ducks had difficulty in freeing themselves when flushed.

## METHODS OF APPROACH

Inasmuch as the object of this study was to disclose the hazards encountered by waterfowl on their breeding grounds and to estimate the losses experienced in their nesting attempts, main reliance was of necessity placed on the field observational method of approach. Despite certain limitations, this procedure yielded convincing information on the effect of predator feeding habits and other suppressive agencies. It also permitted a direct and understandable expression of such an appraisal, which would have been obtainable through no other means. To supplement these field studies, however, and to



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#### DIKE AND ISLAND DUCK-NESTING ENVIRONMENTS.

A. The dikes of a canal traversing Waterhen Lake, Alberta, Canada, the site of a former reclamation project that has reverted to the wild, afforded excellent nesting sites. The concentration of ducks on these dikes, however, induced crows to search the area regularly for eggs. B. On islands in Ministik Lake, Alberta, crows often used the spruces and ducks, the shore-line cover, as nesting sites, which meant that the duck nests were constantly in jeopardy, as the crows could not travel to or from their nests without crossing the duck-nesting area.



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A, Wild-fowl production and intensive agriculture often do not harmonize. The mainland shore, heavily pastured, held no attraction for nesting ducks, which availed themselves of the relative security afforded by an island environment (shown in foreground) to which the cattle did not have access. Ministik Lake, Alberta, Canada. B, Despite this excellent cover that completely hid a mallard's nest from view, crows located and destroyed the eggs. The ladder, which had been washed ashore, may have aided the marauders by affording a convenient means of approach. South Cooking Lake, Alberta.

allow comparisons with other similar material collected in this country, a moderate number of stomachs of crows were collected and subsequently examined, and the results are reported upon in this circular. In the field studies, attempt was made to obtain the completed histories of an adequate and representative series of duck nests. This was carried out in a manner aimed to disturb the nesting birds as little as possible and to give thereby no marked advantage to predators.

#### TECHNIQUE EMPLOYED IN OBSERVATION

Most of the nests were located by methodical search of favorable habitats. They were considered eligible for record upon the laying of the first egg, and studies were terminated when the eggs were hatched, destroyed by outside agencies, or definitely abandoned by the birds. Serial numbers were assigned to them in the order in which found, record being kept in a loose-leaf notebook, one page to the nest. This permitted the addition of data on new nests and the removal of data for nests when their histories were completed. By making successive trips over the several areas in the same or in the reverse order, locating the nests was facilitated.

When a nesting bird was flushed (which was the usual manner in which a nest was disclosed), the vegetation in the vicinity was disturbed as little as possible. Note was taken of the exact location of nest, the species, number of eggs, degree of concealment, character of cover, quantity of down present, proximity and abundance of crows or other possible predators, and any other factors that might have a bearing on the future history or fate of the nest. The nest was then "flagged" by means of a small numbered card, which was either fastened to vegetation so as not to flap in the wind or else placed under rocks, usually about 10 to 50 feet away. Search for new nests and visits to those previously located were stopped whenever crows were nearby, and work was resumed only after they had left the vicinity.

Frequency of visits to the nests varied somewhat with the exigencies of the work. At Waterhen Lake, in 1934, the intervals between visits ranged from 4 days to a week, and in 1935 a period of a week usually was allowed to elapse between visits. With such an interval, the number of visits needed to complete nest histories was reduced. Of the 224 nests under observation in 1935, studies of 86 were terminated at the time of the first visit after their discovery; 45 on the second trip; 47 on the third; 37 on the fourth, and in 9 instances 5 visits had to be made before the history had been completed.

#### IMPORTANCE OF ACCURATE DIAGNOSIS

Next in importance to the need of extreme care in making nest observations is the necessity of correctly reading signs at destroyed nests. Although some of the evidence is difficult to interpret, the work of the crow often is characteristic and plainly evident.

In attacking a nest crows ordinarily destroy the whole clutch of eggs; sometimes, however, they will get their fill short of destruction of the entire set or will leave if the female duck returns to protect and incubate the eggs left. Actual egg eating may take place at or near the nest, or, after having been pecked into, the eggs may be

taken to some bare spot or favorite stump or boulder and there devoured. When the latter procedure is employed, one may find crow-pilfered duck nests with no trace of the shell or contents in the nest, but the telltale evidence may be found at a feeding spot nearby. In preying on eggs that have not been incubated, crows will peck or bite a hole in the shell sufficiently large for them to drink or gobble down the contents. Observations have demonstrated that in making even a small opening into the egg, part of the shell is almost invariably eaten and, when larger apertures are made, much of the shell may be swallowed. It is for this reason that instances of egg eating by crows seldom escape detection in the course of stomach examination.

Throughout these studies care was taken not to charge either the crow or other predators with duck-egg destruction unless the evidence was convincing. Empty nests were not interpreted as cases of crow vandalism unless freshly broken shells of eggs of the species concerned, pecked in characteristic crow fashion, were found nearby. This procedure was adopted despite the fact that snakes large enough to remove duck eggs, if present at all, were not common in the areas studied and therefore had to be ruled out of the picture. Similar conservatism governed decisions with respect to other predators. Whenever a reasonable doubt existed regarding the cause of the destruction of a nest it was considered unknown.

#### POSSIBLE HARM FROM INTRUSION OF OBSERVERS

The nest-history method of approach to studies of this kind has been criticized on the ground that repeated visits of the observer may show predators the way to nests or otherwise reveal their location. Likewise it has been asserted that desertions by the female may be unwittingly increased thereby. The weight of such criticism was recognized from the very beginning of these studies, and every effort was made to keep such disrupting factors at a minimum.

In his appraisal of nest-history studies of the bobwhite in the Southern States, Stoddard<sup>2</sup> came to the conclusion that, in thickly settled country where there was a profusion of trails and tracks made both by human beings and by domestic animals, predators have little to gain by following them with the hope of finding food. He learned also that the percentage of successful hatching was even higher in the group of nests visited repeatedly than in those the history of which had been terminated when first discovered. Stoddard admitted, however, that in unsettled country human tracks might be such a novelty that trailing by predators would lead to increased nest destruction.

Errington,<sup>3</sup> in his suggestions for nest studies in Iowa, while stressing the need of care in making field appraisals of nest misfortunes and admitting the difficulties that arise, looks upon the acquisition of nesting data on hundreds of nests as one of the most practical ways to determine factors governing the welfare of nesting game birds.

<sup>2</sup> STODDARD, H. L. *THE BOBWHITE QUAIL: ITS HABITS, PRESERVATION, AND INCREASE*. 551 pp., illus. New York. 1931.

<sup>3</sup> ERRINGTON, P. L. *SUGGESTIONS AS TO NESTING STUDIES OF IOWA GAME BIRDS*. *Iowa Bird Life* 2: 46-48. 1932.

In analyzing the data accumulated in these studies certain facts were revealed with respect to the degree of interference caused by the intrusion of the observer. One of these concerns the extent of desertion observed, an element that might be construed as an index to any disruption caused by an observer's presence. Of the 512 nests for which histories were completed, 40 or slightly less than 8 percent, were recorded as failures due to desertion (p. 18). In some of these instances it could be demonstrated that the female had returned subsequent to the last previous visit of the observer. In such cases desertion was attributed to "natural causes" and not to interference by the observer. On the other hand, it is likely that some of the nest destruction charged to crows may, in fact, have been cases of desertion due to intrusion by the observer, followed, in turn, by the work of this ever-alert predator, to which a clutch of abandoned eggs, if not actually decayed, is as acceptable as one closely attended by the incubating bird. From the fact that in all cases where down or other cover material was at hand, the investigators made it a point to conceal the eggs carefully before leaving them, it is believed that the number of desertions caused by intrusion, followed by crow attack, was small. The writer is convinced that, when the incubating bird is not actually flushed in the presence of crows, or when its eggs are well covered and the nest is left by the observer reasonably well concealed, his intrusion will not afford the crow an important clue as to nest site.

It cannot be emphasized too strongly, however, that careless intrusion of human beings into duck-nesting areas creates a hazard of utmost importance, for incubating ducks may then be flushed in the presence of crows and the suddenly uncovered eggs left exposed to view. It is for this reason that the breeding grounds of ducks should be carefully guarded against trespass during the nesting season.

#### PROBLEM OF THE CROW ON WATERFOWL BREEDING GROUNDS

Any attempt to appraise the role of the crow in its relation to nesting waterfowl throughout North America must take into consideration the distribution and abundance of the bird and the relationship of its range to that of the various species of waterfowl. Without this information a true and complete perspective of the crow as a predator on wild fowl cannot be obtained.

The crow (*Corvus brachyrhynchos*) is partial to areas devoted to agriculture and to a large extent is now dependent on them. In contrast with the raven (*C. corax*), which has receded with the advance of agriculture, the crow has extended its range in the north to the limits of such development. Beyond the northern border of agriculture, a line that conforms in general with the southern edge of the Canadian Life Zone, the crow is found in numbers only in the vicinity of settlements or clearings in which it can find a semblance of its typical environment. These spots are relatively few, widely scattered, and of limited area, compared with the enormous region extending northward to the Arctic Circle and beyond, in which much of the annual crop of ducks and geese of North America is produced.

The northern limit of the breeding (summer) range of the crow as shown by the heavy line on the accompanying maps (figs. 1-15) indicates the northern limit of the area in which it may be considered "common" to "abundant" and in which waterfowl, if present, might be subjected to undue pressure. The southern limit is something that can not be so clearly defined and about which there is less concern in the present discussion, since it extends below the southern edge of the productive breeding areas of most North American ducks. The area between these limits embraces the ranges of the various subspecific forms of the common crow (*Corvus brachyhyrnchos*), including the more or less maritime northwest crow (*C. b. caurinus*), and the fish crow (*C. ossifragus*), which inhabits the South Atlantic coastal region.

Within the borders of the United States the crow-waterfowl problem involves the relationship of crows to a more dilute population of breeding ducks, scattered over an area somewhat greater than the overlapping ranges of these two groups in Canada. In this country there are extensive areas in which, because of the limited numbers of both crows and waterfowl, there is no crow-waterfowl problem of importance. This is true for much of the East and Southeast, with the exception of certain narrow coastal sections where the few resident ducks may encounter concentrations of fish crows. It also applies to extensive arid and mountainous sections in the West. As a matter of fact the crow-waterfowl problem of this country is restricted largely to the northern States of Minnesota, North Dakota, South Dakota, northern Nebraska, Montana, and sections of the coastal region in the Northwest. The crows of this region, together with those nesting in the Prairie Provinces immediately to the north and in parts of southern British Columbia, constitute the crow population most vitally affecting the welfare of the waterfowl of this continent.

In plotting the nesting areas of waterfowl on the maps, a distinction is made between the present "main breeding area" (indicated by darker cross hatching), much of which has been scarcely affected by the encroachment of civilization and, in recent years, drought; and the "area of reduced abundance" (shown by the horizontal lines), in which a number of factors have conspired to curtail the production of waterfowl. In each of the maps the range of the crow has been superimposed on the breeding ranges of the waterfowl. Consequently it is in the more heavily shaded areas within the limits of the crow's range that one may expect to encounter instances of acute conflict between crows and waterfowl. The explanation of the range maps of 15 common species (pp. 8 to 13) discuss briefly this territorial relationship.

#### EXPLANATION OF CROW-WATERFOWL RANGE MAPS

Of the six species of geese and brant commonly shot as game in the United States, only the Canada goose (*Branta canadensis*) finds the crow a nesting hazard (fig. 1). During recent years, when drought severely curtailed waterfowl nesting in the Northern States,<sup>4</sup> the

<sup>4</sup> BELL, W. B., and PREBLE, E. A. STATUS OF WATERFOWL IN 1934. U. S. Dept. Agr. Misc. Pub. 210, 18 pp., illus. 1934.

effect of the crow was restricted to a negligible part of the total population of Canada geese. Even during earlier years the Canada goose appeared well able to defend its nest against crow attack.

Of the commoner ducks, the wood duck (*Aix sponsa*), goldeneye (*Glaucionetta clangula*), bufflehead (*Charitonetta albeola*), greater scaup (*Nyroca marila*), oldsquaw (*Clangula hyemalis*), harlequin duck (*Histrionicus histrionicus*), the scoters (*Melanitta* and *Oidemia*), eiders (*Polysticta*, *Somateria*, and *Arctonetta*), and many of the mergansers (*Mergus* and *Lophodytes*), by reason of their



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FIGURE 1.—Relation of areas of crow abundance to the breeding range of the Canada goose.

northerly breeding grounds or their modes of nesting, are largely safe from the depredations of the egg-stealing crow. The ranges of these and certain forms that live in the South or the Southwest have not been plotted in maps on pages 9 to 25. The remaining commonly shot ducks, 14 species in all, have breeding ranges that are invaded to a greater or less extent by the crow.

The mallard (*Anas platyrhynchos*), still abundant in the Middle West, nests as far north as the southern half of Alaska, including the Alaska Peninsula, and eastward to the southern shores of Hudson Bay and western Quebec. It encounters the crow in greatest numbers in the northern tier of States from Wisconsin to Montana and in the

southern parts of the Prairie Provinces and southwestern British Columbia (fig. 2). Possibly a fourth of the present productive breeding range of the mallard is today inhabited by the crow in what might be called destructive numbers. The eastern relative of the mallard, the black duck (*A. rubripes*), encounters a crow population of moderate density in the southern third of its breeding range (fig. 3).

The pintail (*Dafila acuta*), with a breeding range that includes all of Alaska and western Canada north to the Arctic Ocean and east to



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FIGURE 2.—Relation of areas of crow abundance to the breeding range of the mallard.

Hudson Bay, contends with destructive numbers of crows from Minnesota to the western edge of the Plains and north to the borders of agriculture in the Prairie Provinces, as well as in part of southern British Columbia, an area that includes less than a sixth of the pintail's productive breeding range (fig. 4).

Of the three teals, the cinnamon (*Querquedula cyanoptera*), nesting largely west of the one-hundredth meridian, encounters the crow in greatest numbers in southern British Columbia (fig. 5). The green-winged teal (*Nettion carolinense*), with a breeding range of irregular shape, extending with breaks to Bering Sea and the mouth of the Mackenzie River, encounters the crow in abundance in Montana, the Dakotas, and the southern part of the Prairie Provinces.

Possibly a fifth of the region in which this teal is today an abundant breeder is included in the region of crow abundance (fig. 6). The blue-winged teal (*Q. discors*), with its less extensive northern distribution, has more than half of its present productive breeding range within the area of great or moderate crow population (fig. 7).

The shoveler (*Spatula clypeata*), despite an irregular distribution that extends far to the northwest, has the crow to contend with over an area equal to about a third of its present range of abundance (fig. 8).



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FIGURE 3.—Relation of areas of crow abundance to the breeding range of the black duck.

Much of the present-day breeding range of the baldpate, or American wigeon (*Mareca americana*), lies north of the area of crow abundance (fig. 9). The remnants of the gadwall (*Chaulelasmus streperus*) population, more southerly in its distribution, are subject to crow pressure along our northern border and in the southern part of the Prairie Provinces (fig. 10).

Of the diving ducks, the redhead (*Nyroca americana*), with its breeding range divided and much reduced in extent, is in most acute contact with crows in the southern part of the Prairie Provinces and in British Columbia (fig. 11), a state of affairs that applies also to the canvasback (*N. valisineria*) (fig. 12). The lesser scaup (*N. affinis*), because of its northern distribution and late nesting, as a

race is not seriously affected by the egg-stealing crow (fig. 13). The ring-necked duck (*N. collaris*) is threatened with crow aggressions over much of its breeding range, possibly more than half its total population being affected thereby (fig. 14).

Although originally the range of the ruddy duck (*Erismatura jamaicensis*) included a large crow-infested area, much of the remaining stronghold of this species lies north of the crow danger zone (fig. 15).

On the basis of the distribution of breeding duck populations in North America today, the species that appear to be in greatest jeop-



B6254M

FIGURE 4.—Relation of areas of crow abundance to the breeding range of the pintail.

ardy from crow depredations are the gadwall and the blue-winged teal. This study also has shown that these two species are particularly vulnerable to crow attack (p. 19). Twelve other common species of ducks, including both deep- and shallow-water forms, are exposed to crow pressure in varying degrees.

It would be difficult to summarize merely in a brief and generalized manner the territorial relationship of crows to the entire North American wild-fowl population, but the statement may be made that not more than a sixth of the area occupied by breeding ducks and geese north of our border is also inhabited by an abundant and potentially destructive crow population. Within the United States proper a crow population, varying in density, may be found on most

of the wild-fowl breeding grounds, with the exception of those in the Great Basin and the Southwest.

In considering the relationships between the crow and the waterfowl in North America as a whole it is to be remembered that in the Northern States and in the southern part of the Canadian Provinces, agricultural development in the past half century has materially thinned the density of breeding wild-fowl populations. Although crows are abundant up to the very edge of agriculture, the number of breeding ducks inhabiting this southerly region is less than formerly, and the density of these populations is generally



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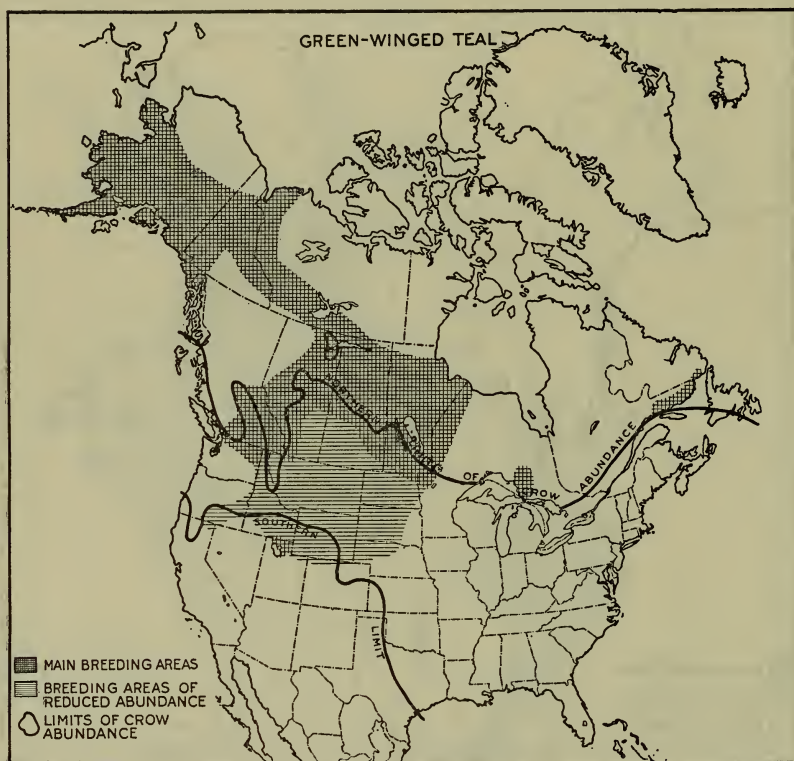
FIGURE 5.—Relation of areas of crow abundance to the breeding range of the cinnamon teal.

considered less than those to the north that breed outside of the range of the crow, agricultural lands, and the drought regions of recent years. Should the efforts now being made to rehabilitate waterfowl in this country result in these birds again becoming abundant in the North Central States, however, the matter of crow pressure on these duck-nesting grounds will become correspondingly more important.

#### CROW ABUNDANCE

Although no detailed census was made of the breeding crows in the areas studied, it is evident that, both in the vicinity of Water-

hen Lake and in the Cooking Lake section there is a greater population of breeding crows than in any region visited by the writer within the borders of the United States. Such a concentration extends up to the very limit of extensively cultivated land. In the pot-hole district about Prince Albert there is a marked diminution in the crow population, and as one travels north from that point into the more heavily wooded Canadian Life Zone, the birds immediately become scarce. Such a condition prevails everywhere beyond the limits of extensive agriculture, and it is only in the vicinity of settlements or clearings that crows are to be found in numbers.



B6256M

FIGURE 6.—Relation of areas of crow abundance to the breeding range of the green-winged teal.

In 1934 the number of crows nesting in the wooded area facing directly on Waterhen Lake (7 miles long and 1 to 2½ miles wide) was estimated to be in excess of 50 pairs. Although only part of these became confirmed egg stealers, yet these were to blame for the destruction of a large number of nests. An appraisal made on the basis of general impressions of abundance at Waterhen Lake placed the ratio of egg-stealing crows to duck nests at about 1 to 20.

On the islands in Ministik Lake crows were relatively even more abundant, and the presence of their nests close to duck-breeding areas

made the situation appear even more precarious for the waterfowl (pl. 1, *B*). Ministik Lake is essentially a scaup lake and, had it not been for the evasion of crow attack by this species through its late nesting, losses due to depredations by the large crow population would have been much more serious.

#### NEST OBSERVATIONS AND ANALYSIS OF RESULTS

Of the 601 duck nests observed during the 2 years' field work, histories were completed on 512. In each of the remaining 89 cases,



B6257M

FIGURE 7.—Relation of areas of crow abundance to the breeding range of the blue-winged teal.

the nest was either lost in the course of the studies (14) or its history incomplete at the time the observations were terminated (75). Of the 512 completed nest histories, 288 were recorded in Saskatchewan (207 at or in the vicinity of Waterhen Lake and 81 in the Prince Albert section), and 224 in Alberta (Cooking Lake area). All of the latter were recorded in 1935, while of the 288 studied in Saskatchewan, 211 were observed in 1934 and 77 in 1935. The varied and pertinent information obtained is presented in tabular form so far as possible and developed and explained in the text.

TABLE 1.—*Outcome of 512 waterfowl nests recorded in Saskatchewan and Alberta, Canada, in the breeding seasons of 1934 and 1935*

| Item no. | Outcome                            | Number | Per-cent <sup>1</sup> | Item no. | Outcome                         | Number | Per-cent <sup>1</sup> |
|----------|------------------------------------|--------|-----------------------|----------|---------------------------------|--------|-----------------------|
| 1        | Hatched (some with reduced broods) | 250    | 49                    | 5        | Female killed by predator       | 9      | 2                     |
| 2        | Destroyed by crows                 | 156    | 31                    | 6        | Destroyed by trampling of sheep | 1      | (2)                   |
| 3        | Destroyed by unknown cause         | 53     | 10                    | 7        | Destroyed by fire               | 1      | (2)                   |
| 4        | Deserted                           | 40     | 8                     | 8        | Eggs taken by collector         | 1      | (2)                   |
|          |                                    |        |                       | 9        | Infertile eggs                  | 1      | (2)                   |

<sup>1</sup> To eliminate confusing and unimportant decimals, the percentages in this and all other tables have been adjusted to the nearest whole number.

<sup>2</sup> Trace.



B6258M

FIGURE 8.—Relation of areas of crow abundance to the breeding range of the shoveler.

## FATE OF THE 512 NESTS

In analyzing the data presented in table 1, it is necessary to consider in conjunction items 1, 2, and 3, which include nine-tenths of the recorded nests, since the line of demarcation between them is in some cases obscure. The hatched nests include all in which the incubating bird succeeded in bringing off at least one young. In some of these a loss of one or more eggs during the period of incubation was due to crow depredations or to other outside factors. In two

instances as many as five eggs were removed—one faithful pintail producing only two ducklings after having started with a set of seven eggs. Consequently, in appraising the hatch from these 250 nests, the actual output was something less than 100 percent. Of the total of 2,147 fertile eggs laid, 73, or 3.4 percent, were pilfered or destroyed during either the laying or the incubating period. Crows, manifestly, had played some part in this destruction.

Item 2, "destroyed by crows", is reasonably accurate and may be taken at its stated value. Egg destruction was not charged against the crow in any case where definite evidence of crow work was lacking, yet some of the nests recorded "destroyed by unknown cause" (item 3) may in fact have been robbed by crows. On the other



B6259M

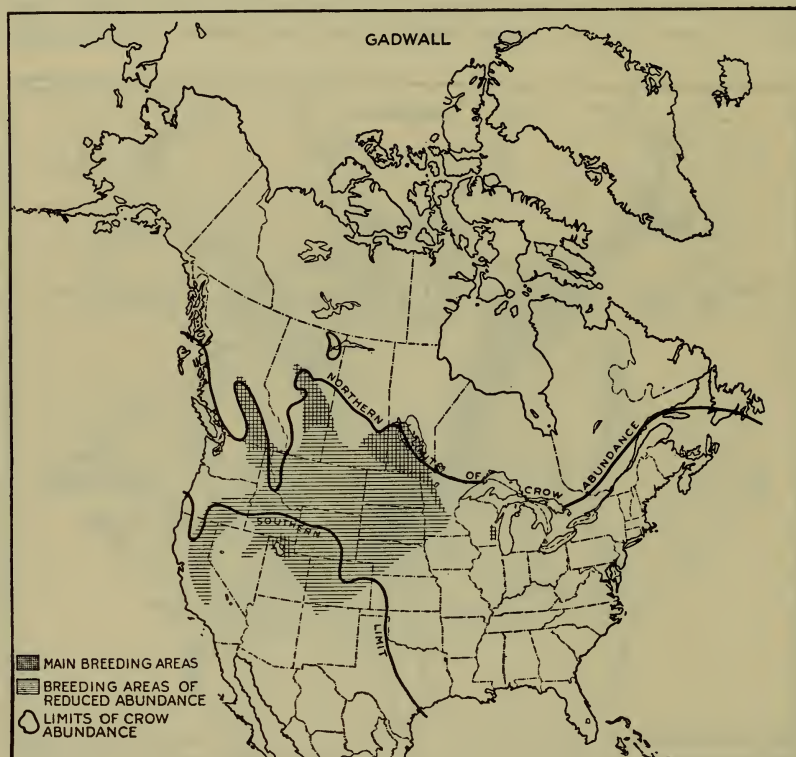
FIGURE 9.—Relation of areas of crow abundance to the breeding range of the baldpate, or American wigeon.

hand, there is the possibility that, in the interval between visits of the observer, nests may have been deserted or the females killed, after which crows may have preyed on what were, in fact, abandoned eggs (item 4).

The nesting duck's attentiveness is looked upon generally as a great aid in the protection of the eggs against predators, particularly the crow. For this reason uncompleted and unguarded sets of eggs have been considered particularly vulnerable to crow attack. In this study, however, analysis of the status of the sets of eggs in the nests

destroyed by crows does not strengthen this contention. Of the 156 nests so destroyed (item 2), 66 contained completed sets of eggs and 17 were definitely incomplete, but for the remaining 73, no certain deduction could be made regarding their completeness.

Included in the 53 recorded instances of destruction by unknown cause (item 3) were the suspected work of the crow, previously mentioned, and also many cases in which the evidence pointed toward but did not definitely incriminate muskrats, skunks, or domestic livestock.



B6260M

FIGURE 10.—Relation of areas of crow abundance to the breeding range of the gadwall.

Though only a relatively small proportion of the nests were deserted by the female (item 4), desertion becomes a matter of more than ordinary interest, since it may reflect some weakness of the observational method of approach to this problem (pp. 4 to 7). In several of the nests that ultimately were deserted, one or more reductions in the number of eggs by outside agencies may have contributed to the inconstancy of the incubating bird. In 10 deserted nests the sets of eggs appeared to have been completed and incubation started, in 13 they were definitely incomplete, and in 15 their status could not be determined. The two remaining deserted nests were "community" affairs into which several females had dropped eggs.

Under item 5 are included several types of disaster in which the females were killed during the egg-laying and incubating periods. In two instances evidence pointed to the work of predatory birds; in five others minks and weasels were to blame; in another an unknown predator was involved; and in the remaining case the female experienced a most unusual fate, for in approaching or leaving her nest one leg became so entangled in a coarse stem of *Carex* that she could not release herself.

Single nests failed to produce young because of an egg collector, trampling by sheep, fire, and infertility (items 6 to 9).

#### FATE OF NESTS OF WATERFOWL OF VARIOUS SPECIES

Segregation of the fate of nests by species brings to light some facts difficult of explanation (table 2). Of the 7 species for each of which there are at least 20 completed nest histories available, it is noted that the canvasback was the most successful in bringing off young, with the shoveler a close second. The mallard, pintail, lesser scaup, gadwall, and blue-winged teal then follow in the order named. That the canvasback nests recorded should have met with more than an average degree of success is not surprising, since 16 of the 29 were from the relatively crow-free pot-hole country about Prince Albert. What factors, however, conspired to permit shovelers to produce young in 64 percent of their nests while other species whose nests were essentially in the same environment and equally vulnerable fared much worse, is not clear.

TABLE 2.—*Analysis by species of the 512 waterfowl nests under observation in Canada, 1934 and 1935*

| Species                  | Total nests | Hatched |         | Destroyed by crows |         | Destroyed by unknown cause |         | Deserted |         | Miscellaneous fates |         |
|--------------------------|-------------|---------|---------|--------------------|---------|----------------------------|---------|----------|---------|---------------------|---------|
|                          | Number      | Number  | Percent | Number             | Percent | Number                     | Percent | Number   | Percent | Number              | Percent |
| Mallard.....             | 188         | 105     | 56      | 54                 | 29      | 15                         | 8       | 10       | 5       | 4                   | 2       |
| Lesser scaup.....        | 94          | 45      | 48      | 26                 | 28      | 13                         | 14      | 8        | 8       | 2                   | 2       |
| Blue-winged teal.....    | 76          | 17      | 22      | 35                 | 46      | 15                         | 20      | 8        | 11      | 1                   | 1       |
| Pintail.....             | 52          | 25      | 48      | 15                 | 29      | 4                          | 8       | 4        | 8       | 4                   | 8       |
| Canvasback.....          | 29          | 19      | 66      | 5                  | 17      | 1                          | 3       | 4        | 14      |                     |         |
| Shoveler.....            | 25          | 16      | 64      | 4                  | 16      | 3                          | 12      | 1        | 4       | 1                   | 4       |
| Gadwall.....             | 21          | 10      | 48      | 10                 | 48      |                            |         |          |         | 1                   | 4       |
| Redhead.....             | 8           | 4       | 50      | 3                  | 37      |                            |         | 1        | 13      |                     |         |
| Ruddy duck.....          | 7           | 4       | 57      | 2                  | 29      | 1                          | 14      |          |         |                     |         |
| Baldpate.....            | 5           | 4       | 80      | 1                  | 20      |                            |         |          |         |                     |         |
| White-winged scoter..... | 2           |         |         |                    |         | 1                          | 50      | 1        | 50      |                     |         |
| Goldeneye.....           | 1           | 1       | 100     |                    |         |                            |         |          |         |                     |         |
| Green-winged teal.....   | 1           |         |         |                    |         |                            |         | 1        | 100     |                     |         |
| Unknown.....             | 3           |         |         | 1                  | 33      |                            |         | 2        | 67      |                     |         |
| Total.....               | 512         | 250     | 49      | 156                | 31      | 53                         | 10      | 40       | 8       | 13                  | 2       |

Of the 7 waterfowl species represented by 20 or more nests, table 2 reveals that gadwalls fared the worst from crows, although the blue-winged teal suffered almost as badly. The 76 nests of the blue-wings yielded a total of only 163 ducklings, whereas, if each had produced its quota of 10.78 young (an average computed from the completed sets encountered in this study), the total would have been 820. The other well-represented species, placed in the order of their vulnerability to crow attack, are the pintail, mallard, lesser scaup, canvasback, and shoveler.

Had it been feasible to remain on the breeding grounds until studies of the last nests under observation could be completed, an improvement in the hatching record of scaups doubtless would have been noted. Most of the 75 nests on which studies had not been terminated when the field work was brought to a close were those of scaups. With conditions for the successful hatching of the eggs increasing daily near the close of the work, the addition of the records of 75 late nests would have materially increased the ratio of successful hatching.



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FIGURE 11.—Relation of areas of crow abundance to the breeding range of the redhead.

#### SEASONAL VARIATIONS IN THE FATE OF NESTS

To ascertain the degree of success of early as against late nests, a division was made of the data pertaining to the 512 completed nest histories (table 3). This division, in which the termination dates of the various nest histories were used as the basis of segregation, was made at about the middle point of the field-study period in each of the two seasons. In the Saskatchewan studies of 1934 this division fell between June 18 and 19; in Alberta in 1935 it came between June 23 and 24; and in the studies made in the vicinity of Prince Albert in 1935 the division was placed between June 16 and 17.

TABLE 3.—Comparison of early and late nestings, showing outcome data for each half of the nesting season

| Outcome                         | First half of season |         | Second half of season |         | Outcome                  | First half of season |         | Second half of season |         |
|---------------------------------|----------------------|---------|-----------------------|---------|--------------------------|----------------------|---------|-----------------------|---------|
|                                 | Number               | Percent | Number                | Percent |                          | Number               | Percent | Number                | Percent |
| Hatched.....                    | 66                   | 36      | 184                   | 56      | Female killed.....       | 5                    | 3       | 4                     | 1       |
| Destroyed by crows.....         | 85                   | 47      | 71                    | 22      | Miscellaneous fates..... | 1                    | (1)     | 3                     | 1       |
| Destroyed by unknown cause..... | 17                   | 9       | 36                    | 11      | Total.....               | 184                  | 100     | 328                   | 100     |
| Deserted.....                   | 10                   | 5       | 30                    | 9       |                          |                      |         |                       |         |

<sup>1</sup> Trace.

B6262M

FIGURE 12.—Relation of areas of crow abundance to the breeding range of the canvasback.

It will be noted that there is a marked general improvement in the extent of successful hatching during the second half of the season and a corresponding decrease in the frequency of crow depredations. What is shown concretely in the table was even more apparent through field observations, which in many ways brought forth evidence of the lessened pressure exerted by crows as the season advanced. Toward the close of the studies, young crows of the year's hatch were out of the nest and had joined their parents in family groups that spent much of their time in the newly cut hayfields, on

summer fallow, or along roads. The duck-nesting environment no longer held the attraction to them that it had earlier in the year.

It has already been pointed out (p. 17) that incompleting sets of eggs did not fare worse than completed sets. It is also shown (p. 24) that poorly concealed nests, so frequently seen early in the season, did not meet with greater disaster than those well concealed. Yet the history of the whole group of nests clearly shows a marked increase in the number of successful hatchings as the season advances. This may be further emphasized by the explanation that, of the



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FIGURE 13.—Relation of areas of crow abundance to the breeding range of the lesser scaup duck.

last 42 nests terminated in the Cooking Lake district in 1935, 33—nearly 80 percent—produced young birds.

The reason for this seemingly anomalous situation may be found in the seasonal change in the habits of crows. Although from their very nature, duck eggs cannot furnish an appreciable proportion of the volume of food of nestling or adult crows, such food items have their maximum attraction for crows during their own reproductive period. At such times easily obtainable animal food is eagerly sought, particularly for the female under the strain of egg laying or under the confinement of incubation. Unless future studies alter matters, it would seem that, at least near the border line of agricul-

ture in the Prairie Provinces, crow damage to duck eggs is governed fully as much, if not more, by the nutritional demands or changing feeding habits of the crow itself as by an early-season vulnerability of duck nests.

The higher degree of success attained in late-season nestings calls for some comment on the possibility of second broods faring better than the first. This study provides nothing of a statistical nature on this subject, since it was impossible to define the status of many of the midseason nests, although a few extremely late nests of species



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FIGURE 14.—Relation of areas of crow abundance to the breeding range of the ring-necked duck.

that normally are early nesters might have been construed as second layings. This difficulty was accentuated in 1935, since the nesting season was 10 days to 2 weeks late, and many of the pintails and mallards did not settle down to nesting until in June.

Considering the time element alone as presented at the border line of agriculture in the Prairie Provinces, it would be possible for early nesting pintails, mallards, and some of the canvasbacks to have their nests destroyed and yet have ample time to remate and hatch a second laying at a time of year when the chance of success is better. It is not known what proportion of the midseason nesters, including the redhead, gadwall, ruddy duck, wigeon, shoveler, and blue-winged

teal, could raise a second brood in time to put them on the wing by the beginning of the fall migration. With the white-winged scoters and the scaups the chance of successfully raising a late brood is not favorable.

There is still much to be learned concerning the reaction of the various species to the loss of their eggs. It is not known what proportion of the birds will find their old or acquire new mates; build new nests; lay new sets of eggs; or patiently incubate them. If the second sets are smaller in size than the first, as some infer<sup>5</sup>, the question arises whether the advantage of better nesting conditions late in the season might not be offset by a reduced number of eggs. These and other questions must be answered before the full significance of second layings can be appraised. It may be pointed out, however, that because of the shorter summer in Canada, the time element in the production of a brood from a second clutch is more decisive there than in the United States.

#### CONCEALMENT IN RELATION TO FATE OF NESTS

In the course of the nest-history studies note was made of the nature and degree of concealment of the nest proper as it might be viewed by avian or mammalian predators. Although this was an appraisal through human eyes and according to human ideas of visibility and might not therefore reflect conditions as viewed by wild creatures, the degree of concealment as referred to in table 4,

TABLE 4.—*Degree of concealment of nests, and the outcome from each class*

| Degree of concealment | Total nests | Hatched |         | Destroyed by crows |         | Destroyed by unknown cause |         | Deserted |         | Miscellaneous fates |         |
|-----------------------|-------------|---------|---------|--------------------|---------|----------------------------|---------|----------|---------|---------------------|---------|
|                       | Number      | Number  | Percent | Number             | Percent | Number                     | Percent | Number   | Percent | Number              | Percent |
| Poor.....             | 137         | 86      | 63      | 34                 | 25      | 10                         | 7       | 4        | 3       | 3                   | 2       |
| Fair.....             | 126         | 53      | 42      | 38                 | 30      | 18                         | 14      | 12       | 10      | 5                   | 4       |
| Good.....             | 175         | 70      | 40      | 61                 | 35      | 25                         | 14      | 17       | 10      | 2                   | 1       |
| Excellent.....        | 57          | 31      | 54      | 18                 | 32      | 4                          | 7       | 4        | 7       | -----               | -----   |
| Total.....            | 1 495       | 240     | -----   | 151                | -----   | 57                         | -----   | 37       | -----   | 10                  | -----   |

<sup>1</sup> That the total number of nests here recorded is less than the 512 for which histories were completed is due to failure to classify the degree of concealment of 17; percentages are therefore omitted in the footing.

by the designations "poor", "fair", "good", and "excellent", conveys at least a relative idea of their visibility. Nests poor in concealment had little or no cover immediately above them, and at times the sitting bird could be seen from a distance. Those excellently concealed were wholly obscured from above and from the side, and the cover had to be parted or held aside before the nest proper could be seen (pl. 2, *B*). Nests considered fair or good in concealment were intergrades between the extremes described.

That adequate cover is essential to the welfare of most ground-nesting birds is generally recognized. This is particularly true in the case of waterfowl. It is with more than ordinary interest, therefore, that the fate of the Canadian duck nests was studied in rela-

<sup>5</sup> BENNETT, L. J. A COMPARISON OF TWO IOWA DUCK NESTING SEASONS. Amer. Game Conf. Trans. 21: 277-282. 1935.



B42065; B42072

SUCCESS AND FAILURE IN HATCHING.

A, Nest of mallard on island in Ministlik Lake, Alberta, Canada, that was reasonably well concealed from above by an arch of dead stems of round bulrush. The square cut shells and membranes of the eggs indicate a successful hatch. B, Typical crow work at nest of a canvasback, Sisib Lake, Alberta. The eggs had been destroyed when the nest was discovered by the investigators.



tion to that all-important factor, cover or concealment. The results presented in table 4 are quite at variance with what one would expect and they lead to the inference that perhaps human ideas of adequate concealment may not be correct or that the crows and other creatures that prey on ducks and their eggs are able, through astuteness, keenness of sight, or stealth, to overcome the protective advantage of what man sees fit to call adequate concealment (pl. 3, 4). Then, too, there is the great likelihood that those individual ducks



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FIGURE 15.—Relation of areas of crow abundance to the breeding range of the ruddy duck.

whose nests are in exposed situations guard them more zealously and refuse to leave when danger impends.

Of the nests that terminated in hatchings, the highest degree of success was had by that group adjudged to have had poor concealment. Although the nests considered to possess optimum protection by reason of their excellent concealment showed a higher hatch than those with good or fair concealment, yet the successful hatching in the "excellent" group was materially below that of the poorly concealed nests. Equally startling deductions may be made when these data are scrutinized from the viewpoint of crow depredations (pl. 3, B). Analysis of the data pertaining to nests destroyed by unknown causes, or terminated by desertion and miscellaneous agencies, reveals somewhat the same state of affairs, those apparently

poorly concealed usually faring as well or even better than those that seemed excellently concealed.

#### LOCAL ENVIRONMENT AND FATE OF NESTS

As a basis for appraising the relation of local environmental conditions to the fate of nests, the habitats have been grouped (table 5) into six categories, referred to as (1) the dikes of Waterhen Lake, (2) open marsh, (3) pot holes, sloughs, and small lakes, (4) the bush, (4) open fields, and (6) island environments.

TABLE 5.—*Analysis of outcome of nests by type of environment in which situated*

| Environment                              | Total  | Hatched |         | Destroyed by crows |         | Destroyed by unknown cause |         | Deserted |         | Miscellaneous fates |         |
|------------------------------------------|--------|---------|---------|--------------------|---------|----------------------------|---------|----------|---------|---------------------|---------|
|                                          | Number | Number  | Percent | Number             | Percent | Number                     | Percent | Number   | Percent | Number              | Percent |
| Dikes at Waterhen Lake.....              | 221    | 102     | 46      | 74                 | 33      | 20                         | 9       | 17       | 8       | 8                   | 4       |
| Open marsh.....                          | 37     | 11      | 30      | 15                 | 40      | 7                          | 19      | 4        | 11      | 0                   | 0       |
| Pot holes, sloughs, and small lakes..... | 76     | 40      | 53      | 19                 | 25      | 8                          | 10      | 8        | 10      | 1                   | 2       |
| Bush.....                                | 6      | 2       | 33      | 1                  | 17      | 1                          | 17      | 2        | 33      | 0                   | 0       |
| Open fields.....                         | 5      | 3       | 60      | 1                  | 20      | 0                          | 0       | 1        | 20      | 0                   | 0       |
| Island environment.....                  | 167    | 92      | 55      | 46                 | 28      | 17                         | 10      | 8        | 5       | 4                   | 2       |
| Total.....                               | 512    | 250     | 49      | 156                | 31      | 53                         | 10      | 40       | 8       | 13                  | 2       |

Conditions on the dikes at Waterhen Lake have been described on pages 2 to 3 (pl. 1, *A*). The open marsh included expansive areas distant from either timber or shore line. The pot-hole, slough, and small-lake environment, typified by the country about Prince Albert, as well as by certain sections in Alberta, was characterized by numerous water areas of small size, each inhabited by one or a few pairs of ducks. By the "bush" is meant timbered areas, large or small, at the edges of which mallards, pintails, and the tree-nesting species nested, sometimes under dense cover and at a considerable distance from water. Open-field nests often were distant from water and usually unprotected by arboreal growth. The island environments, forming the second largest habitat group, have already been discussed (p. 4), and were restricted to Hastings, Ministik, and Big Island Lakes southeast of Edmonton (pl. 1, *B*).

The data in table 5 show that better-than-average success in hatching was obtained in the island, pot-hole, and open-field environments, although in the case last named the conclusion is based on five nests. The dike environment of Waterhen Lake, open-marsh areas, and the bush gave results less favorable than the average, although here again nests in the last category were few in number.

Leaving out of consideration the few nests in the bush and open-field environments, the most severe crow pressure was exerted on waterfowl on the dikes of Waterhen Lake and on open-marsh areas; whereas the pot-hole and island environments were most favorable for the ducks. A segregation of the data covering the nests in the pot-hole district about Prince Albert, where crows were less abundant, reveals an even more favorable situation. Only 3 of the 45 duck nests recorded in that section were despoiled by crows, and 33 of them hatched successfully.

## FOOD OF CROWS AS REVEALED BY STOMACH EXAMINATION

To supply corroborative evidence of the fate of duck nests as revealed by field observation and to determine what proportion of the food of crows is obtained from the eggs and young of wild ducks in the area studied, 68 stomachs (25 of adults and 43 of nestlings) were collected in the Waterhen Lake district during the summer of 1934. These have since been examined in the laboratory and in presenting the results the food of adults and of nestlings will be discussed separately. Additional stomach material was also collected in Alberta in 1935 but the analyses were not available for this study.

## ADULT CROWS

The various items making up the food of adult crows at Waterhen Lake, but not pertinent to crow-waterfowl relationships, can be passed over with the statement that the aggregate of all insect food items approximates that of adult crows in the United States taken during the same months (May, June, and July)<sup>6</sup> and that the vegetable portion is characterized by an abundance of wheat instead of Indian corn.

Remains of birds' eggs were found in 17 of the 25 stomachs of adult crows. In 4 of the 17 the shell fragments were definitely identified as eggs of ducks, in 12 others they were listed as "probably duck eggs"; and in the remaining instance the egg involved was apparently that of a meadowlark. In a single stomach the downy feathers of a young bird, probably a duckling, were found along with eggshell. In bulk, this material formed 4 percent of the aggregate stomach contents of the 25 adult crows. Compared with this degree of egg destruction on duck-nesting grounds in Canada, the writer<sup>6</sup> has found that 500 adult crows collected in the United States under varied conditions during the same season of the year had obtained a little more than 1 percent of their food from wild birds or their eggs.

The differences in the degree of bird and egg destruction in the two environments is brought out even more strongly when the case is stated on the basis of frequency with which these items appear in the stomachs. In the Canadian material, eggs (and in one instance, a young bird) occurred in 68 percent of the stomachs, while in 500 stomachs of adult crows collected in the United States during the same season, similar items appeared in only 33, or 6.6 percent.

## NESTLINGS

In their general food habits the 43 Canadian nestling crows varied somewhat from those that have been collected in the United States. Only 32 percent of their food consisted of insects, as against 48 percent for the latter group. As was the case with the adults, small grains, including wheat, barley, and oats, took the place of Indian corn, the staff of life of crows in this country.

Remains of birds and their eggs were found in stomachs of 25 of the 43 nestlings from Canada. Of the 25, 21 contained shells of

<sup>6</sup> KALMBACH, E. R. THE CROW AND ITS RELATION TO MAN. U. S. Dept. Agr. Bull. 621, 93 pp., illus. 1918.

birds' eggs, of which 7 were definitely, and 5 tentatively, identified as those of ducks. The other egg remains were of small passerine birds. The downy feathers of ducklings were identified in three instances; grebe feathers in four; and the remains of young coots in two. In a few instances both eggs and feathers of birds were found in the same stomach. It was also revealed that all the individuals of a brood of young crows might be fed portions of the same item. Under such conditions the evidence of a single act of vandalism may be recorded in several stomachs.

In bulk, the remains of birds and eggs in the stomachs of the 43 nestling crows from Canada comprised 10 percent of the food. Nestling crows collected in the United States under a variety of conditions had subsisted on similar food to the extent of only 1.57 percent of their diet. Whereas birds and their eggs appeared in 58 percent of the stomachs of nestling crows collected in Canada, similar food was present in only 9 percent of 778 nestlings collected in the United States.

Summarizing the foregoing, it may be said that adult crows in Canada took four times the quantity of other birds and their eggs that those in the United States did; and that the nestling Canada crows took six times the quantity eaten by the young in this country. Stated on the basis of the frequency with which such controversial items are eaten, it may be said that the adult Canada crow is 10 times as culpable as the crow in the United States; while the nestling Canada crow is 6 times as bad in this respect as are nestlings raised south of the border.

This pronounced bird-and-egg destruction by crows in Canada is due, not so much to their northern situation as to the local environment where they were collected. Conditions at Waterhen Lake were favorable to the nest-destroying activities of crows. On the other hand, although the crows collected in the United States may have reflected average conditions in this country, the crow-waterfowl factor was largely absent from the environments in which stomachs were collected.

#### FATE OF DUCKLINGS

Study in the field yielded little information regarding the extent of mortality among ducklings from the time they are hatched until they are old enough to fly. Stomach examination, however, disclosed the remains of a duckling in 1 out of 25 adult crows and in 3 of 43 nestling crows. Whether all these ducklings were killed by crows or some were found as carrion could not be determined.

Although reports reached the investigators of the killing of ducklings by both crows and California gulls (*Larus californicus*), no instances came under their observation. Four dead scaup ducklings were found in one nest just after the eggs had hatched. Three of these had been decapitated, and the evidence pointed to the work of a weasel or a mink.

It is obvious that there will be certain losses during the period when the ducklings are small. These are accentuated and may even become serious when drought or absence of adequate cover compels the female to herd her brood long distances across open areas en route to bodies of water and shelter. When water levels are normal

and there is adequate marsh cover, such losses are materially reduced, and the crow, in particular, has little chance to prey upon the young.

A general impression of the extent of loss that may be suffered by young broods under conditions fairly favorable to their welfare may be had from data obtained in the course of these studies. Notation was made of the number of eggs found in all completed sets, and later counts were made of the young in single broods. A comparison of these data, with respect to lesser scaups, mallards, gadwalls, pintails, and canvasbacks, all obtained in the Cooking Lake district in 1935, shows with each species a reduction in the number of young as compared with the number of eggs. This information, grouped by species, is presented in table 6. The apparent losses are not outstanding with respect to any one species and may be looked upon as evidence of a natural and general drain, due to a number of causes. These no doubt include the crow, but such obscure factors as parasites, disease, accidents, and climatic conditions also play a part.

TABLE 6.—Comparison of the number of eggs in completed sets with the number of young in broods

| Species           | Eggs   |                                | Ducklings |                                       | Species         | Eggs   |                                | Ducklings |                                       |
|-------------------|--------|--------------------------------|-----------|---------------------------------------|-----------------|--------|--------------------------------|-----------|---------------------------------------|
|                   | Sets   | Average number of eggs per set | Broods    | Average number of ducklings per brood |                 | Sets   | Average number of eggs per set | Broods    | Average number of ducklings per brood |
|                   | Number |                                | Number    |                                       |                 | Number |                                | Number    |                                       |
| Lesser scaup..... | 50     | 9.54                           | 16        | 8.00                                  | Pintail.....    | 7      | 7.14                           | 3         | 6.00                                  |
| Mallard.....      | 45     | 7.84                           | 32        | 7.10                                  | Canvasback..... | 7      | 11.70                          | 10        | 8.70                                  |
| Gadwall.....      | 12     | 10.50                          | 4         | 8.50                                  |                 |        |                                |           |                                       |

#### VALUE OF REMEDIAL MEASURES

This investigation has clearly indicated a heavy pressure exerted on nesting waterfowl by the crow in Canadian areas where it is conspicuously abundant. That being so, certain queries arise. Shall remedial measures be employed? If so, what kind? And, lastly, what result can be expected? The answer to the last of these questions will in large measure determine the nature and extent of any remedial action warranted.

Justly alarmed over a high degree of egg destruction such as is revealed by these studies, many urge unrestricted and unrelenting warfare upon the crow to remove what they feel is a potent hindrance to the recuperation of the waterfowl. They are convinced that such efforts would soon result in an appreciable increase in the number of North American game birds. In arriving at such conclusions two assumptions often are made: The first is that egg destruction by crows is everywhere as great as that disclosed in the Canadian localities studied; the second, that crows on this continent are to be found in destructive numbers wherever ducks breed.

As a matter of fact the waterfowl areas selected for study were those in which the crow was expected to be at its worst. The results

obtained, therefore, are not to be construed as average for the whole Dominion; nor are they to be interpreted as representative of crow-waterfowl relationships throughout this country. Future studies alone will show whether the 31-percent destruction of duck nests observed holds generally for all the duck-breeding grounds on this continent that lie within the crow's range of abundance.

As pointed out elsewhere (p. 12), the range of the crow in destructive abundance embraces only a part, possibly a sixth, of that great waterfowl area north of the United States which today is the reservoir from which come most of the ducks and geese. Since one cannot determine, even within broad limits, the fractional part of the actual wild-fowl population that is exposed to pronounced crow pressure, the matter can be disposed of only with the statement that the destruction of waterfowl eggs by crows, if prorated for the entire wild-fowl population of North America, will average materially less than the 31 percent recorded in the area studied. It is the writer's opinion that loss from this source will in the aggregate be less than 10 percent of the eggs laid. In areas heavily infested with crows, however, particularly on the waterfowl breeding grounds of the southern parts of the Prairie Provinces and in the North Central States, an egg loss approaching that disclosed in these studies may result.

To prevent such losses the difficult task of eliminating the crow would be necessary, and any effort falling short of complete elimination would be expected to fail proportionately in accomplishing its object. It is possible also that if the crow should be eliminated, other factors, now more or less inconsequential, might react to an increased yield of waterfowl and become correspondingly more potent suppressive agencies. Only actual control on a substantial scale, on experimental areas, accompanied by careful observations on its ultimate effect on the waterfowl population, will give the final answer to the value of crow control.

#### ON BREEDING GROUNDS OF WATERFOWL

On or about the breeding grounds of waterfowl, crow control takes on much the aspect of guerrilla warfare. Although crows may be abundant as breeders, there are no dense concentrations that can be attacked economically at that season. The cost per bird killed, therefore, is bound to be high whatever the method employed. Yet it is on the breeding grounds that crow control would give the most direct benefits to the harassed waterfowl. Individual crows, favorably located, are likely to become confirmed egg stealers and obtain much of their food at the expense of nesting ducks; others, not greatly distant, may conduct themselves less objectionably. The persistent marauder must be sought individually and its career ended.

This brings us to the crux of the whole problem of crow control on waterfowl breeding grounds: Control must be undertaken by those who have an intimate knowledge of the areas involved, a familiarity with the habits of local bird life, and a full appreciation of the hazards to waterfowl created by human intrusion at the nesting time. Without such appreciation, efforts at crow control may react disastrously on the very waterfowl it is sought to aid. On

refuges and other areas under supervision, the resident warden or caretaker usually is in the best position to deal with egg-stealing crows. Under no conditions should large groups of loosely supervised crow hunters, operating as they frequently do on a competitive basis, be allowed to intrude on waterfowl nesting areas during the spring months.

Three methods of crow control on breeding grounds are at the disposal of the trained refuge caretaker and game manager—shooting, trapping, and poisoning. When the area is not too large and the crows not too numerous, shooting with a small-bore rifle is effective and does not unduly disturb nesting ducks. Such operations may well be delayed until all the crows have taken up their nesting sites and there is little likelihood of the arrival of additional migrants. In the Northern States such operations can be started in April; in Canada in May. In both regions they can be continued until the objectionable resident crows in and about the waterfowl areas have been removed. During the nesting season a crow call, imitative of a young bird, and a mounted owl exposed near a concealed shooting stand, will be found effective in luring adults within gunshot. Effort should be made to get both the male and female of each nest, and, if there are young, these also should be dispatched.

A .22-caliber rifle, with or without telescope sights, using standard long-rifle ammunition will be found satisfactory. The higher powered ammunition, discharging .22-caliber bullets at greater velocities, is not recommended in thickly settled areas because of the menace to human beings and livestock. Away from the immediate vicinity of nesting grounds the shotgun may be used with greater freedom.

Trapping with steel traps is a useful practice at the disposal of a refuge caretaker to eliminate individual egg-stealing crows. Such traps (no. 0 or no. 1) may be used in connection with a "set", baited either with hen's egg or the body of a ground squirrel or other rodent. The jaws may be padded to prevent injury to beneficial creatures that may be caught accidentally. Traps may with advantage be set near the scene of previous egg destruction, as crows often return to such places.

The use of poison in crow control on breeding grounds has both advantages and disadvantages. Moreover, it may be legal or illegal, depending on local laws and regulations, which must be respected at all times. Before any further consideration of the subject, however, it cannot be too emphatically stated that poisoning is a procedure to be shunned by persons unfamiliar with its use and its dangers. In the hands of the experienced, however, poison can be used with a reasonably high degree of selectivity, safety, and effectiveness.

A hen's egg is the ordinary medium for conveying poison for egg-stealing crows, and strychnine is the usual poison employed. In island environments or on extensive areas where valuable dogs or fur bearers would not get them, such eggs may be put in dummy nests placed on or near the ground; elsewhere the nests should be placed well above the ground. In thickly settled sections, the use of poisoned eggs should be scrupulously avoided, since crows often will carry and drop them at distances from the baited area. These eggs usually are prepared by being partially blown, after which,

with a hypodermic needle and syringe, a small quantity of poison in solution is injected, the contents well shaken, and the aperture in the shell sealed with a piece of adhesive tape.

#### AT WINTER ROOSTS

Contrasted with the time-consuming and expensive, but highly selective, procedure of disposing of particular egg-stealing crows on breeding grounds is the alternative of crow control at winter roosts, where, at a much lower cost per bird, large numbers have been removed by trapping, shooting, poisoning, or dynamiting. Winter gatherings of crows are made up of individuals that breed over an enormous range and in a great variety of environments, and only part of these birds are concerned in crow-waterfowl relationships during spring and summer months—what that proportion is no one at present knows. The efficacy, therefore, of winter crow-control operations as an aid to the betterment of waterfowl conditions on breeding grounds far to the north cannot be stated definitely, though on the average it must be small. Unless winter-control operations should result in a decided reduction in the aggregate number of crows throughout the country, it is doubtful to the writer whether a noticeable improvement in the continental supply of waterfowl would result.

Although fall and winter crow control can be defended on some areas as a local crop-protection measure (and there are ample reasons for further research into such methods of control) no one should become overly sanguine regarding the possible benefits resulting to waterfowl. Regardless of the method or the season chosen for control, it must be remembered that crows are highly mobile and resourceful and that reinvasions may be expected into areas from which they have been extirpated. Permanent advantages from control operations will rest on continued effort, and any ground that may have been gained may be easily lost through a lapse in the operations.<sup>7</sup>

#### SUMMARY

To gather data on crow-waterfowl relationships, studies were made during the nesting seasons of 1934 and 1935 in the vicinities of Prince Albert and Waterhen Lake, Saskatchewan, and southeast of Edmonton, Alberta, the field observation being supplemented by stomach examination. Complete histories were obtained of 512 nests of ducks and the fate of each was determined as far as the facts could be ascertained. Despite the care used, the intrusion of the observer may have affected the results somewhat in favor of the crow and other predators, at least with respect to the extent of nest desertion. About Waterhen Lake, Saskatchewan, and Cooking Lake, Alberta, where most of the nest histories were obtained, the abundant population of breeding crows was reflected in the extent of nest depredations. On the other hand, in the pot-hole district about

<sup>7</sup>Methods of combatting crows destructive to crops are presented in the following: KALMBACH, E. R. THE CROW IN RELATION TO AGRICULTURE. U. S. Dept. Agr., Farmers' Bull. 1102, 20 pp., illus. 1920. This bulletin may be obtained from the Office of Information, Department of Agriculture, Washington, D. C., without charge, as long as the supply lasts.

Prince Albert, where breeding crows were less abundant, only moderate losses were suffered by nesting ducks. For this reason the findings of this study cannot be construed as representative of conditions everywhere in Canada and much less so on breeding grounds in the United States. The essential findings may be summarized as follows:

1. Of the 512 duck nests studied, 250 (49 percent) produced young. In some instances the number of the eggs was reduced by one cause or another before hatching. Crows were definitely chargeable with the destruction of 156 nests (31 percent), though some of these may have been deserted by the female before the eggs were eaten. Unknown causes accounted for the loss of 53 nests (10 percent). Nests deserted by the female numbered 40 (8 percent), and the remaining 13 (2 percent) met miscellaneous fates, at 9 of which the incubating bird was killed by predators.

2. Of seven species of ducks for each of which at least 20 completed nest histories are available, the canvasback and shoveler were most successful in producing young, while the gadwall and blue-winged teal fared the worst. Many of the canvasback nests were near Prince Albert, a section where the crow population was less dense.

3. Despite the fact that poorly concealed nests or incomplete sets of eggs were found not to have suffered more from crow attack than those well hidden or with full complements of eggs, there was a decided improvement in the extent of hatching as the season advanced. This would indicate that egg destruction by the crow in Canada is governed as much by the nutritional demands and habits of the crow itself as by any early-season vulnerability of the nests.

4. Though some of the early-nesting pintails and mallards have time to hatch second layings, when the chance of success is greater, it is not known what proportion of the midseason nesters could do likewise. Late-nesting scaups are even less likely to have the young from second nestings hatched and on the wing before the advent of cold weather and the opening of the hunting season.

5. Local environmental conditions were reflected in the fate of nests; those in "open-field", "island", and "pot-hole" environments having fared better than those found on the dikes at Waterhen Lake or in the "open-marsh" areas elsewhere.

6. Stomach examination revealed that adult crows in the Canadian duck-nesting environments averaged four times as many birds and eggs eaten as do adult crows living under average conditions in this country. At the same time nestling crows north of the border ate six times the quantity of such food that nestlings to the south did. This indication of pronounced bird and egg destruction is due largely to the fact that all the crows collected in Canada were obtained in close proximity to duck-nesting grounds, whereas those collected in this country were taken in a variety of environments, among which duck-nesting grounds were infrequent, if not entirely lacking.

7. No pronounced mortality of ducklings was attributable to the work of crows or other predators. If there is ample marsh cover and water levels are stable the female ducks are not forced to lead their young long distances to water and losses of the ducklings from this cause are not excessive.

8. Since the areas studied were selected with the idea of witnessing the crow at its worst probably a higher degree of egg destruction was revealed than would be the average throughout the range of the crow on this continent. Furthermore, since the crow is found in abundance on only part of the waterfowl breeding areas, the aggregate egg loss, if prorated for the entire waterfowl population of North America, would be materially less, possibly not more than a tenth of the eggs laid. Locally, however, there may be egg losses approaching those indicated by these studies among waterfowl that breed in the southern part of the Prairie Provinces and in the North Central States.

### CONCLUSIONS AND RECOMMENDATIONS

Field studies of the fate of duck nests in Canada reveal that there are areas near the northern border of agriculture in Saskatchewan and Alberta in which the presence of an inordinately dense crow population is a menace to duck-nesting marshes, but that where crows are less abundant, as in the pot-hole country about Prince Albert, Saskatchewan, losses are correspondingly less severe.

Waterfowl have been the victims of the combined effects of overshooting, drought, disease, predators, and destruction of habitat, but the crow in Canada has suffered little from any of these and has even profited to the extent that agriculture has displaced the bush with open fields, grain crops, and plowed land. In recent years crows that nest in the Prairie Provinces have found also on their winter range in Kansas and Oklahoma an increased and copious food supply in the milo, kafir, and other sorghum crops. These circumstances favor the abundance of the crow at the expense of waterfowl.

Although the findings of this study are sufficiently disturbing to merit attention in programs of waterfowl restoration where crows are numerous, unwarranted conclusions and ill-advised action should be carefully guarded against. On the areas studied the crow was probably at its worst. Its normal role as a predator on the eggs of waterfowl throughout Canada and the northern United States is yet to be determined, but the indications point to its being less severe than these studies have revealed. In any event, it is to be remembered that the range of the crow in destructive numbers now covers only a part (possibly a sixth) of the whole productive waterfowl nesting area in Canada and Alaska. Beyond the limits of these overlapping ranges there is no serious crow-waterfowl problem.

Waterfowl, in common with all other bird life, can ordinarily withstand what might be termed "natural losses" during the reproductive period. The fecundity of most species is sufficient to compensate for any ordinary drain. Where, however, conditions similar to those encountered in these studies arise on important areas dedicated primarily to the welfare of nesting waterfowl, rational crow control should become an integral part of any game-management program.

Crow-control operations on duck-breeding grounds should by all means be entrusted only to those who fully recognize the hazards associated with human intrusion on waterfowl nesting grounds. The work should not be carried out haphazard or by mass action devoid of careful supervision. There should, in fact, be solicitude for the

privacy of every nesting duck. At winter crow roosts, where control is possible at a lower cost per bird, the benefits with respect to waterfowl are, in turn, less direct, since only a part of the birds present at these roosts (number at present unknown) actually enter the problem of crow-waterfowl relationships on the breeding grounds.

For the present, and probably for years to come, such control may wisely be restricted to those Federal, State, or privately managed areas to which crows have been attracted in unduly large numbers by the presence of nesting waterfowl and on which the consequently delicate problem of control may be kept in experienced hands.

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